Discretized versions of flow statistics and parameters

We collect here discretized versions of flow statistics and parameters, in order to clarify the implementations made for the post-processing.

Shear velocity

$$u_\tau = \sqrt{\frac{\tau_w}{\rho}} \approx \sqrt{\nu \frac{U(2)}{y_p(2)}}$$

where

- $U(2)$ is the mean streamwise velocity at the face between the first two grid elements at the wall and,
- $y_p(2)$ is the related y coordinate.

Displacement thickness

$$\delta^* = \int_0^\infty 1 - \frac{\langle u \rangle}{u_\infty} dy \approx L_y - \sum_{j=1}^{n_y} \langle u \rangle_j \Delta y_j$$

where

- u_∞ is assumed unitary,
- L_y is the size of the domain in y direction,
- n_y is the number of discretization points in y direction,
- Δy_j is the mesh spacing (distance between faces),
- $\langle u \rangle_j$ is the mean velocity at the discretization points (faces of the elements; 'forward' or 'backward' rectangular rule can be used).

In a temporal BL, it is modified as:

$$\delta^* = \int_0^\infty \frac{\langle u \rangle}{U_w} dy \approx \sum_{j=1}^{n_y} \langle u \rangle_j \Delta y_j$$

where U_w is the velocity of the translating wall.

Momentum thickness

$$\theta = \int_0^\infty \frac{\langle u \rangle}{u_\infty} \left(1 - \frac{\langle u \rangle}{u_\infty} \right) dy \approx \sum_{j=1}^{n_y} \left(\langle u \rangle_j - \langle u \rangle_j^2 \right) \Delta y_j$$

where

- u_∞ is assumed unitary,
- n_y is the number of discretization points in y direction,
- Δy_j is the mesh spacing (distance between faces),
- $\langle u \rangle_j$ is the mean velocity at the discretization points (faces of the elements; 'forward' or 'backward' rectangular rule can be used).

In a temporal BL, this formula remains the same.